# Exhibit A

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OKLAHOMA COOPERATIVE EXTENSION SERVICE

# How to Get a Good Soil Sample

Hailin Zhang
Director, Soil, Water and Forage Analytical laboratory

Gordon Johnson
Nutrient Management Specialist

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Soil tests provide a scientific basis for evaluating available plant nutrients in cropland, pastures, lawns, and gardens. Analyses of soil samples can help farmers and homeowners fine-tune nutrient applications from fertilizers, biosolids, and animal manure. Properly managing the amount of nutrients added to the soil can save money and protect the environment.

Soil nutrients vary by location, slope, soil depth, soil texture, organic matter content, and past management practices, so getting a good soil sample stands out as a major factor affecting the accuracy and usefulness of soil testing. This fact sheet outlines some specific considerations which should be taken into account to get the greatest benefit from soil testing.

## Sample Soil at the Right Time

Fields used for production of cultivated crops may be sampled any time after harvest or before planting. Generally, two weeks should be allowed for mailing, analysis, and reporting of results. Additional time may need to be allotted for ordering and application of fertilizers, manure, or lime materials. Noncultivated fields should be sampled during the dormant season. In either case, do not sample immediately after lime, fertilizer, or manure applications because those samples do not represent the true soil fertility.

Fields should be tested annually to measure the available nitrogen pool or as frequently as necessary to gain an understanding of how soil properties may be changing in relation to cultural practices and crop production.

## Collect a Representative Sample

Getting a representative sample is simple, but not easy. Research at OSU and other universities has clearly shown that a minimum of 20 cores or small samples taken randomly from the field or area of interest are necessary to obtain a sample which will represent an average of the soil in the field (Figure 1). These cores should be collected in a clean plastic bucket (to avoid metal contamination) and mixed thoroughly by hand. The sample bag should be filled from the mixture. A one pint (OSU soil sample bag full) sample is usually adequate for all tests which might be required. If the sample is too wet to mix, it should be spread out to dry some and then mixed, or sampling should be delayed until the field is drier.

It is important to remember that the sample obtained by the above procedure will be an *average* of the area sampled. If the area sampled is extremely variable in the soil properties which are going to be tested, then it may be better to separate

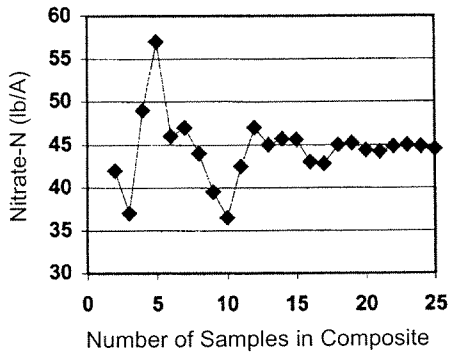


**Figure 1. The minimum number of core samples needed to make a representative composite sample is about 20.**

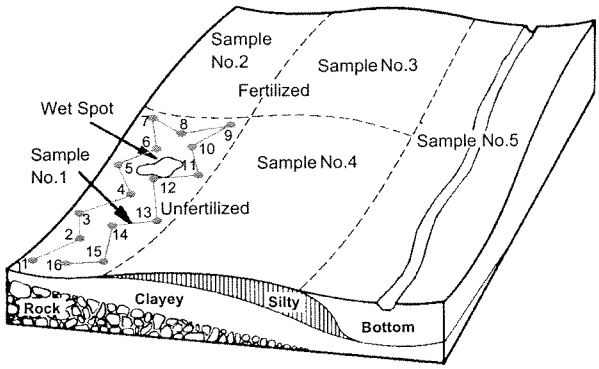


**Figure 2. Divide field into uniform sampling areas and follow a random pattern when sampling. Avoid unusual spots and try to obtain a representative sample.**

the field into smaller areas, and get a representative (20 cores) sample from each of these areas in order to determine how variable the field is (Figure 2). In this way, it may be possible to treat some areas of the field differently from others and remove variability so that the field can be sampled and treated as a unit in the future. Variability in a field can often be noted by differences in surface soil color and crop growth or yield.

Using only one sample for a large variable field can be very costly. Since the sample represents an average of the soil in that field, recommendations based on the soil test will likely cause the field to be overfertilized on some parts and

underfertilized on other parts. Failure to obtain uniform response to treatments based on a soil test is frequently a result of one sample being used to represent a large variable field.

An example of field variability is shown in Table 1. The range of test values was obtained by testing 40 individual cores taken at random from an "apparently uniform " 80-acre field. The variation is great enough so that for some analyses the average is not a good representation of the field. Areas of the field with the lowest pH, phosphorus, and potassium values will not receive adequate lime or fertilizer if recommendations are based on the average test values.

A single core sample, or spadeful, is extremely risky because it may test anywhere in the range shown for each of the analyses. For example, deficiencies for wheat could range from zero to 37 pounds of $P_2O_5$ and zero to 34 pounds of $K_2O$. For alfalfa, which has much greater nutrient requirements, deficiencies could range from zero to 94 pounds of $P_2O_5$ and zero to 120 pounds of $K_2O$. This would also affect the amount of nitrogen and lime required. Obviously, unless the 80 acres is divided into less variable units for testing, some areas of the field will receive either too much or too little fertilizer and lime.

In deciding how large an area can be represented by one composite sample (20 cores), the determining factor is not the number of acres involved, but rather, the variability of the area. Some large, uniform fields can be represented well by a single 20-core sample, while some highly variable fields need to be split into two or more smaller areas for testing. Regardless of the field size or main area being sampled, unusual spots in the field (salty or wet spots) should be avoided during the initial random sampling. When unusual spots make up a significant area, they should be sampled separately.

## Sample at Proper Depth

### Cultivated Fields

For most soil tests the sampling depth is the tillage depth. The reason for this is because most crops have their greatest root activity in the tillage depth. Obtaining a representative sample with regard to depth means that each of the 20 cores taken from an area should be from similar depth, tillage, or six inches. Soil tests are generally calibrated on the basis of an acre furrow slice, approximately two million pounds of soil in the top six inches.

For deep-rooted nonlegumes such as wheat, bermudagrass, sorghum, and cotton, a separate sample representative of the subsoil should be taken in addition to the tillage depth or six-inch sample. This subsoil sample should represent the layer of soil from 7 to 24 inches below the surface. Because nitrate-nitrogen is mobile in the soil, a test of available nitrogen (and/or chloride and sulfate) in the subsoil sample will provide a more complete picture of available mobile nutrients for these crops (Figure 3) and can save fertilizer expenses.

### No-till Fields

Noncultivated fields should be sampled to a depth of six inches, again because this is the effective depth of most treatments and the depth of most root activity. Nutrients from fertilizer, animal manure, and lime can be accumulated on the surface if they are surface applied without incorporation. A set of samples from the top two inches will help identify stratification of nutrients and is especially important for pH determination for no-till fields. If nutrient loss in runoff is the main concern, the two-inch sample is better than a six-inch sample because only the surface inch or two is in direct contact with surface runoff.

### Salinity Diagnosis

When salt accumulation is suspected as a cause of poor stand establishment and the sample is being taken after planting, then the depth of sampling should approximate the seeding depth (one to three inches). This is especially important when conditions have been favorable for soluble salts to move upward and accumulate near the surface after planting. Since excess salts are most harmful to germination and seedling vigor, it is this shallow depth which should be tested. At other times during the year, a sample of the entire tillage depth may be most useful to test for salt accumulation.

## Send Samples for Analysis

Soil sample bags are available at local county Extension offices. Extension offices will mail your samples to the OSU Soil, Water and Forage Analytical Laboratory and assist you to interpret test results.

**Table 1. Variability of an 80 Acre Field Based on Soil Tests of 40 Individual Soil Cores .**

| | *Soil Test Values* | |
|---|---|---|
| *Analysis* | *Range* | *Average* |
| pH | 4.9-6.3 | 5.6 |
| BufferIndex | 7.1-7.4 | 7.3 |
| Nitrogen | 1-34 | 11 |
| Phosphorus | 23-114 | 36 |
| Potassium | 149-770 | 306 |

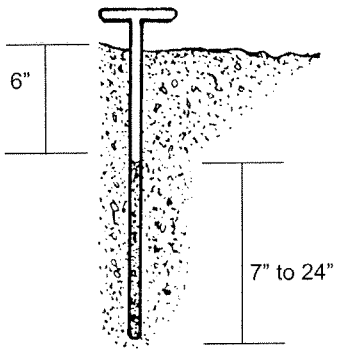


**Figure 3. A soil probe is a good tool for obtaining soil samples. Push the tube to the six-inch depth and remove the core. Then take the seven to 24-inch core through the same hole for the subsoil test.**

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OKLAHOMA COOPERATIVE EXTENSION SERVICE

# Sampling Animal Manure

Hailin Zhang
Waste Nutrient Management Specialist

Douglas W. Hamilton
Waste Management Specialis

James G. Britton
Area Poultry Specialist

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**http://www.osuextra.com**

The accuracy of a chemical analysis is only as good as the sample sent to the lab. The sample collected should closely represent the material used as a fertilizer. Manure collected at one point in the system may be completely different from manure collected at another point. Manure characteristics can also change with the seasons. Sample and analyze manure close to the time when it will be used. If you only use it during a certain time of the year, sample during that time. Take samples at least once per year and whenever manure handling procedures change. If manure is used throughout the year, sample more frequently. Many laboratories supply sampling kits on request. Always consult with the lab before collecting samples. The representative sample collected may become useless, if the proper shipping and preservation procedure is not used.

## Sampling Techniques

### Litter Inside a Broiler or Pullet House

Dry litter varies across the width of the house—material near the curtains is different from that under feeders and waterers. There are also differences between brood and growout areas and even the north and south sides of a house. These differences must be considered to get a representative sample. The following techniques allow samples to be taken with birds in the house.

***Trench Method***

Using a shovel (a narrow spade works well), dig a trench as wide as the shovel across half of the broiler house (Figure 1). Start at the center line of the house and dig a trench in the litter to the sidewall. If there is cake, cut the caked litter to the width of the shovel and collect it too. Place the entire contents of the trench on a tarp or drop cloth. Thoroughly mix the litter using a hoe. Place a portion of this well-mixed litter into a zipper-closing plastic bag. Place it in a second bag. Use the litter remaining on the tarp to backfill the trench.

***Zigzag Method***

Walk the entire house in a zigzag pattern (Figure 1) and grab 15 to 20 subsamples with a shovel or coffee can. Collect the entire depth of the litter, but be careful not to remove soil beneath the litter. Place subsamples in a plastic bucket, and mix thoroughly. Take a small sample from the bucket and place in a zipper-closing plastic bag. Place in a second plastic bag.

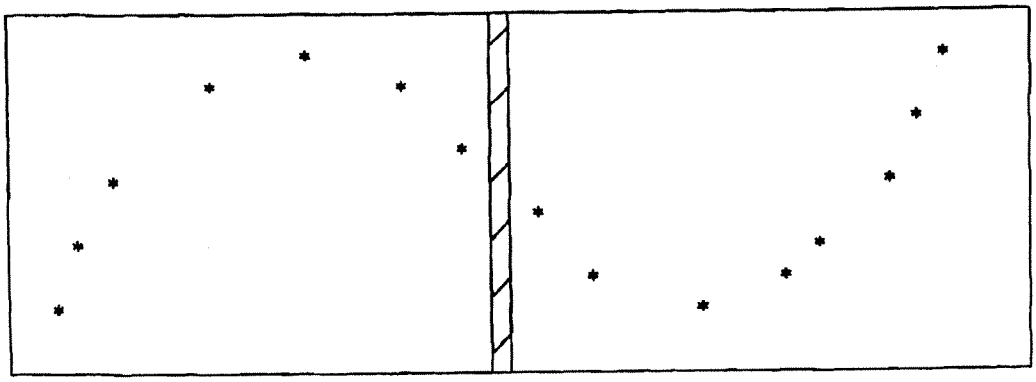

**Figure 1. Taking poultry litter samples in the house using trench and zigzag methods.**

### Litter Inside a Breeder House (partially slatted)

A composite sample from a partially slatted breeder house can be sampled by collecting sub-samples from both slatted and litter areas. In all collect at least 20 sub-samples to get a representative sample of the building. Since 2/3 of the house is under slats, and 1/3 is litter area, collect 14 cores from under the slats and 7 samples from the litter area. Sample through the slats using a soil probe or section of pipe. Collect litter samples similar to the zigzag method above. Place slat and litter samples in a plastic bucket and mix thoroughly. Take a small sample from the bucket and place in a zipper-closing plastic bag. Place in a second plastic bag.

### Lagoon Effluent

If you only pump effluent from the top of a lagoon, you only need to take a sample from the upper two feet. Samples taken from the upper layer of the lagoon should represent the contents of the layer for several weeks, although lagoons do change from month to month. It is a good idea to sample lagoon effluent during the season of year you intend to irrigate. For instance, if you plan to irrigate bermudagrass in May and wheat in August, then take two effluent samples—April-May for the bermudagrass, and July-August for the wheat.

#### *Bucket-Toss Method*

A simple effluent sampler is a rope attached to a small plastic bucket. Throw the bucket out into the lagoon and let it sink. Slowly pull the bucket back to shore, being careful not to collect scum or solids with the sample. Then swirl the bucket and pour a subsample into a plastic container.

#### *Dipper Method*

Dipping is less accurate than the bucket-toss method. But if you object to handling an effluent covered rope, use a plastic bottle securely taped to a long pole. Make sure the pole is long enough to reach over any scum collected at the edge of the lagoon. Dip out a number of samples at different depths and locations, then mix the samples together in a bucket. Swirl the bucket and pour a subsample into a plastic container.

### Entire Lagoon Contents

Sometimes, producers need to analyze the entire contents of a lagoon, or they need to measure chemicals deeper than two feet in the lagoon. Lagoons separate into layers (Figure 2). The bottom of the lagoon contains sludge. A scum or crust may form at the top of the lagoon. Between the sludge and scum is a large volume of liquid. To determine the total contents of a lagoon for diagnostic purposes, you must put together a sample from all the layers. You have two choices—collect a complete column of the lagoon profile or collect material from each layer and mix it into a composite sample based on the mass of each layer. Either way means getting out on the lagoon in a boat.

#### *Column Sampler*

A number of column samplers are commercially available. All are basically a long hollow tube (Figure 2) that is slowly lowered into the lagoon. Once the sampler reaches the bottom, the tube is closed off, so you can raise the entire column from the lagoon. Be sure the sampler is long enough to reach the bottom of the lagoon and wide enough to collect an undisturbed sludge sample.

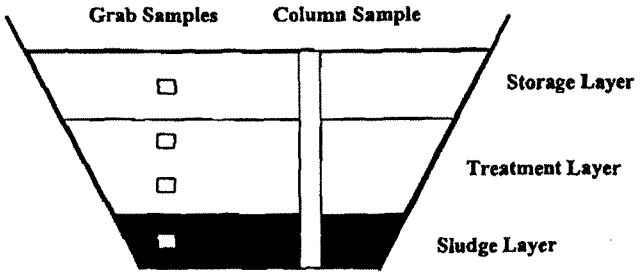


**Figure 2. Sampling entire lagoon contents.**

#### *Grab Sampler*

A discrete or grab sample is a small sample taken from one layer (Figure 2). The idea is to grab the sample without disturbing layers above or below it. Discrete samplers use water pressure to force sludge or liquid into the sampler. The "Sidewinder" sampler is an easy to build grab sampler for lagoons. (Plans are available. Contact your county Extension educator). Once collected, discrete samples may be analyzed separately or combined into a composite sample for the whole lagoon.

### Slurry From a Waste Storage Pond or Settling Basin

Layers form in a waste storage pond just as they do in a lagoon. Sampling the entire contents of the pond requires the same techniques as a lagoon. Storage ponds are mixed before slurry is spread on the field as fertilizer. You can use the bucket-toss or dipper methods to collect samples from ponds. But the pond must be agitated first! Solids contents change as the pond is pumped. Take small samples over the entire pumping period and mix into a larger sample. Remove a small subsample from the well mixed sample and place in a plastic container.

### Slurry From Pre-fabricated Storage Structures

Above ground storage structures are agitated before spreading. The return line on a pump agitator should have a valve to allow you to take samples. Take a number of small samples while emptying the storage structure. To collect samples from a propeller-agitated pit, use the bucket-throw or dipping method. Remove a small subsample from the well-mixed sample and place in a plastic container.

### Slurry or Semi-Solid From Pits Beneath Slotted Floors

Column samplers that are used to sample lagoons work in storage pits as well. Homemade column samplers work just as effectively, though. Take a section of plastic pipe narrow enough to slip through the floor slots, but wide enough to collect undisturbed solids. Lower the pipe through the slots until you feel the bottom of the pit. Cap the upper end, trapping a column of manure. Empty the entire contents of the pipe into a plastic bucket. Take samples from a number of locations

throughout the pit. Swirl or mix the contents of the bucket and pour a subsample into a plastic container.

### Solid and Semi-Solid Manure Off Feedlot Surfaces

Using soil probe, take a minimum of 20 cores randomly from the pen surface. Walk the entire area of the pen in a zigzag pattern to make sure you remove cores from all areas. Be careful to remove only manure and not the hardened soil beneath. Collect cores in a plastic bucket and mix them thoroughly. Take a small sample from the bucket and place it in a zipper-closing plastic bag. Place the bag in a second plastic bag. Manure characteristics change with the age of cattle and other management differences, so you should sample representative pens of the same age and similar management practices.

### Solid Manure From Stockpiles and Dry Stacks

Using a shovel, remove samples from several locations of at least 18 inches into the pile. Place subsamples in a plastic bucket. Mix, but do not allow the material to dry. Place a portion of the sample in a plastic bag. For added safety, place the bag in a second plastic bag.

### Liquid and Slurry During Land Application

Sometimes it is easier to get a representative sample by collecting samples during application. However, the total N concentration of samples collected in the field may be lower than samples taken from storage because some ammonia is lost during application. Contact your local Extension educator or crop consultant before using samples collected in the field for fertilizer recommendations.

#### *Catch Cans In the Field*

This technique is especially useful if slurry is spread from a honey wagon or tank truck. Randomly place a number of cans in the field. Collect waste from the cans and mix in a large bucket immediately after spreading. Swirl the bucket to mix the contents and pour a subsample into a plastic container.

#### *Slurry or Liquid From a Big Gun Sprayer*

Some big gun sprayers have a valve at the spray riser used to drain the hose. Place a bucket under the valve and open while the gun is running. Open the valve slowly! Big guns operate at high pressures. Collect a number of samples while pumping, and mix together. Take a subsample from the well mixed material and place in a plastic container.

#### *Sample Liquids From a Sprinkler Nozzle*

Impact sprinklers and LEPA spray nozzles work at lower pressures than big guns, so it is safe to collect a sample directly from the spray stream. Place a bucket or cylinder directly in the stream. In large irrigation systems, collect a number of samples at different locations. Mix samples into a composite. Take a subsample of the well mixed liquid and place it in a plastic container.

## After Collecting Samples

Ship liquid and slurry samples in a quart-sized plastic bottle with a screw top lid. Only fill the bottle half full to allow for gas expansion. Squeeze flexible bottles slightly before screwing on the lid. Place solid and semi-solid samples in zipper-closing plastic bags. Place a second plastic bag over both liquid and solid samples for extra safety. Use cardboard boxes to ship sample bottles and bags. Pack the box tightly with expanded styrofoam peanuts or shredded paper and seal with strapping tape.

Preservatives are generally not needed for manure samples used for fertilizer recommendations. Other analyses may require special shipping and preservation. This is especially true when collecting samples for biological or bacteriological analysis.